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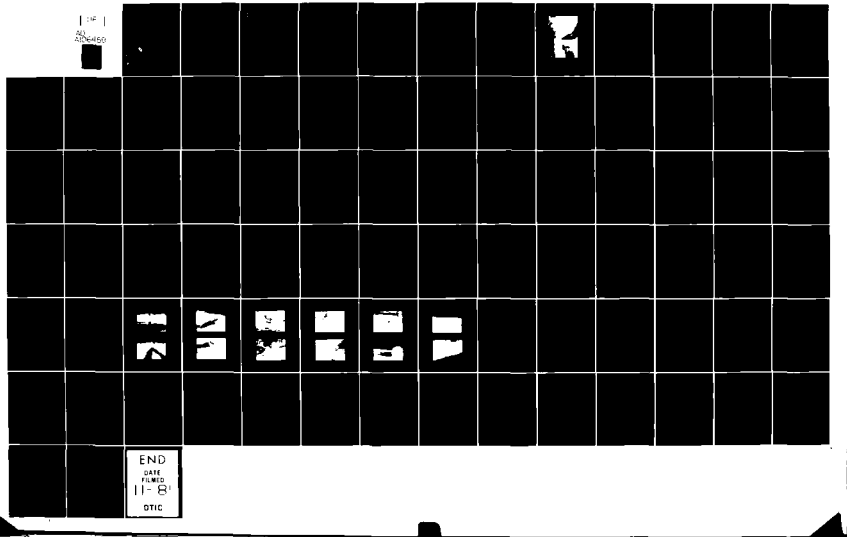

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SUNRISE LAKE DAM
JEFFERSON COUNTY, MISSOURI
MO. 31190

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
Serving the Army
Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

JULY 1981

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO ATTENTION OF

SUBJECT: Sunrise Lake Dam (Mo. 31190) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Sunrise Lake Dam (Mo. 31190).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

a. The spillway will not pass 50 percent of the Probable Maximum Flood without overtopping the dam.

b. Overtopping of the dam could result in failure of the dam.

c. Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED
Chief, Engineering Division

23 JUL 1981
Date

APPROVED BY: SIGNED
Colonel, CE, Commanding

24 JUL 1981
Date

SUNRISE LAKE DAM
JEFFERSON COUNTY, MISSOURI

MISSOURI INVENTORY NO. 31190

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY
PRC CONSOER TOWNSEND, INC.
ST. LOUIS, MISSOURI
AND
PRC ENGINEERING CONSULTANTS, INC.
ENGLEWOOD, COLORADO
A JOINT VENTURE

UNDER DIRECTION OF
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
FOR
GOVERNOR OF MISSOURI

JULY 1981

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam: Sunrise Lake Dam,
Missouri Inventory No. 31190
State Located: Missouri
County Located: Jefferson
Stream: Unnamed tributary of Joachim Creek
Date of Inspection: May 7, 1981

Assessment of General Condition

Sunrise Lake Dam was inspected by the engineering firms of PRC Consoer Townsend, Inc. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture) in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Located within the estimated damage zone of less than three miles downstream of the dam are at least nine dwellings, one building, one downstream dam (Clear Lake Dam (Mo. 30437)) and a county highway (Highway V), which parallels Joachim Creek, all of which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Sunrise Lake Dam is in the small size classification since it is 32.5 feet high and has a maximum reservoir impoundment of 262 acre-feet.

The inspection and evaluation indicate that the spillway system of Sunrise Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Sunrise Lake Dam being a small size dam with a high hazard potential is required by the guidelines to pass from one-half of the Probable Maximum Flood to the Probable Maximum Flood without overtopping the dam. Considering the small size of the dam, the reservoir storage capacity, and the number of dwellings in the downstream hazard zone, one-half of the Probable Maximum Flood is considered the appropriate spillway design flood for Sunrise Lake Dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. It was determined that the reservoir/spillway system can accommodate approximately 20 percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system will accommodate the one-percent chance flood (100-year flood) without overtopping the dam.

The overall condition of the dam appears to be fair; however, several deficiencies were noted by the inspection team. These deficiencies included: seepage under the spillway slab; cracks and spalling of the concrete in the spillway; the erosion of the banks of the discharge channel of the spillway; the erosion of the upstream slope due to wave action; several shallow surface sloughs observed on the embankment slopes; the presence of saplings and brush on the embankment slopes and trees along the downstream, right abutment/embankment contact; a need for periodic maintenance of the grass cover; and a lack of a maintenance schedule. There exists a need for periodic inspection by a qualified engineer. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above. Increasing the spillway capacity should be undertaken on a high priority basis. All other remedial measures should be accomplished within a reasonable period of time.

Walter G. Shifrin, P.E.

Overview of Sunrise Lake Dam

NATIONAL DAM SAFETY PROGRAM

SUNRISE LAKE DAM, I.D. No. 31190

TABLE OF CONTENTS

TABLE OF CONTENTS

(Continued)

TABLE OF CONTENTS

(Continued)

LIST OF PLATES

APPENDICES

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

SUNRISE LAKE DAM, Missouri Inv. No. 31190

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Sunrise Lake Dam was carried out under Contract DACW 43-81-C-0063 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of PRC Consoer Townsend, Inc. of St. Louis, Missouri, and PRC Engineering Consultants, Inc. of Englewood, Colorado, (A Joint Venture).

b. Purpose of Inspection

The visual inspection of Sunrise Lake Dam was made on May 7, 1981. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site and of the structural adequacy

of the various project features, and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the west abutment or side, and right to the east abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase I Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection and conversations with Mr. Paul N. Shy. Mr. Shy designed and constructed the dam. No design or "as-built" drawings for the dam or appurtenant structures were available.

The dam is a homogeneous, rolled, earthfill structure placed between earth abutments with a 12-foot-wide core trench excavated to solid bedrock, according to Mr. Shy. A plan and elevation of the dam are shown on Plate 4 and Photos 1 through 3

show views of the dam. The top of dam has a length of 445 feet between the right abutment and the spillway. The minimum elevation of the top of dam was found to be 742.1 feet above mean sea level (M.S.L.) at the spillway. From the spillway, the top of dam sloped upward and downward in varying degrees to the right abutment contact. The right end of the dam was determined to be 3.3 feet higher than the left end. The embankment has a top width of 14 feet and a maximum structural height of 32.5 feet. The downstream slope was measured to be 1 vertical to 2 horizontal (1V to 2H). The upstream slope was also measured to be 1V to 2H above the water surface on the day of the inspection. The axis of the dam consists of two straight segments, which intersect at a point 160 feet from the left end of the dam. The left side of the dam is skewed about two degrees from the right side in the downstream direction.

There is only one spillway at this damsite, which consists of a concrete-lined open channel located on the left abutment (see Photo 5). The control section of the spillway is a concrete weir situated at the inlet to the spillway (see Photo 4). The weir crest has an assumed elevation of 739.0 feet above M.S.L. and has a crest length of 60 feet. The weir crest is 1.7 feet wide and is 0.9 feet above the invert of the spillway channel. An access road, which crosses the dam embankment, passes through the spillway channel just downstream of the weir. At this point, the channel is five feet deep and has side slopes of 1V to 8H and 1V to 5H on the left and right sides, respectively. Near the downstream end, the channel is 3.4 feet deep with a bottom width of 24 feet and side slopes of 1V to 2.5H and 1V to 3.5H on the left and right sides, respectively. The invert of the channel drops 12.1 feet in elevation in the 98-foot distance from the weir to the downstream end. Flow through the spillway channel cascades down a discharge channel, which is lined with bedrock and has near vertical side slopes of raw earth (see Photo 6). The discharge channel leads directly into the reservoir of Clear Lake Dam (Mo. 30437) immediately downstream of this dam.

No low-level outlet was provided at this damsite.

b. Location

Sunrise Lake Dam is located in Jefferson County in the State of Missouri on an unnamed tributary of Joachim Creek. The location of the dam on the 7.5 minute series of the U.S. Geological Survey maps is found in the southwest quarter of Section 36 of Township 39 North, Range 4 East, of the Vineland, Missouri Quadrangle Sheet (Advance Print, see Plate 2). The dam is located approximately six miles southeast of De Soto (see Plate 1).

c. Size Classification

The maximum reservoir impoundment of Sunrise Lake Dam is 262 acre-feet. This is less than 1,000 acre-feet but more than 50 acre-feet, which would classify it as a "small" size dam. The maximum height of the dam of 32.5 feet is less than 40 feet and greater than 25 feet, which also classifies it as a "small" size dam. The size classification is determined by either the storage or height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "small" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the downstream area, our findings concur with this classification. Located within the estimated damage zone, which extends less than three miles downstream of the dam, are at least nine dwellings, one

building, one downstream dam (Clear Lake Dam (Mo. 30437)), and a county highway (Highway V), which parallels Joachim Creek (see Photos 5, 11, and 12).

e. Ownership

Sunrise Lake Dam is privately owned by the Lake Land Retreat Property Owners Association. The mailing address is as follows: Lake Land Retreat Property Owners Association, c/o Mr. Robert Sells, President, Lake Land Retreat, Rural Route 3, P.O. Box 149-1, De Soto, Missouri, 63020.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

According to Mr. Paul N. Shy, the original owner of Sunrise Lake Dam, the dam was designed and constructed by his own construction company during 1960 and 1961. No drawings or specifications pertaining to the design or construction of the dam were available.

The following information, which pertains to the construction of the dam, was obtained from Mr. Shy. The dam was constructed using rubber-tired scrapers and bulldozers. The embankment material was placed on the fill in thin layers and compaction of the material was achieved by the activity of the earthmoving equipment; however, no compaction control was employed. Material used for the embankment was a fine clay borrowed from the reservoir area. A 12-foot-wide core trench was excavated along the axis of the dam to solid bedrock. Concrete used in the spillway was reinforced with wire mesh, and a one-foot-deep cutoff wall was provided below the weir wall.

h. Normal Operational Procedures

Normal operational procedures are to allow the reservoir to remain as full as possible. The water level is controlled by rainfall, runoff, evaporation, seepage, and the crest elevation of the spillway weir.

1.3 Pertinent Data

a. Drainage Area (square miles):. 1.31

b. Discharge at Damsite

Estimated experienced maximum flood (cfs): 356

Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs): 1,185

c. Elevation (Feet above M.S.L.)

Top of dam (minimum):. 742.1

Spillway crest:. . . . . 739.0 (assumed)*

Normal Pool: 739.0

Maximum Experienced Pool:. 740.5

Observed Pool: 739.0

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):. 2,600

e. Storage (Acre-Feet)

Top of dam (minimum):. 262

Spillway crest:. 175

Normal Pool: 175

Maximum Experienced Pool:. 215

Observed Pool: 175

f. Reservoir Surfaces (Acres)

Top of dam (minimum):. 32.0

Spillway crest:. 23.0

Normal Pool: 23.0

Maximum Experienced Pool:. 28.5

Observed Pool: 23.0

g. Dam

Type:	Rolled, Earthfill
Length:	445 feet
Structural Height:	32.5 feet
Hydraulic Height**:	32.5 feet
Top width:	14 feet
Side slopes:	
Downstream.	1V to 2H (measured)
Upstream.	1V to 2H (from the top of dam to the elevation of the water surface on the day of the inspection)
Zoning:	Homogeneous
Impervious core:	None
Cutoff:	A core trench excavated to bedrock, according to Mr. Shy
Grout curtain:	None
Volume:	27,500 cu.yds. (estimated)

h. Diversion and Regulating Tunnel. . . . .None

i. Spillway

Type:	Concrete-lined open channel with a weir inlet, uncontrolled
Location:	Left abutment
Length of crest:	60 feet
Crest Elevation (feet above M.S.L.):	739.0 (assumed)

j. Regulating Outlets . . None

* The elevation of the crest of the spillway is assumed to be the elevation of the reservoir as shown on the U.S.G.S. Vineland, Missouri Quadrangle topographic map (Advance Print). The elevation of other features of the dam are obtained by using this elevation and field measurements.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface, if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

No design drawings or data are available for Sunrise Lake Dam.

2.2 Construction

No construction records or data are available relative to the construction of the dam, other than the construction history given in Section 1.2g.

2.3 Operation

No documented operational records or data are available for the dam.

2.4 Evaluation

a. Availability

The availability of engineering data consists only of the State Geological Maps, a general soil map of the State of Missouri published by the Soil Conservation Service, and U.S.G.S. Quadrangle Sheets.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. The conclusions presented in this report are based on field measurements, past performance and present condition of the dam. The available data including the field

measurements taken by the field inspection team are considered adequate to evaluate the hydraulic and hydrologic capabilities of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

No valid engineering data pertaining to the design or construction of the dam were available.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Sunrise Lake Dam was made on May 7, 1981. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Soils
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
James Nettum, P.E.	PRC Engineering Consultants, Inc.	Civil-Structural and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
Rupp Reitz	PRC Consoer Townsend, Inc.	Civil-Structural

Specific observations are discussed below.

b. Dam

The overall condition of the dam appears to be fair; however, a few items of concern were observed and are described below.

The top of dam supports an asphalt access road used by the local residents to gain access to their homes (see Photo 2). The road provides excellent protection for the top of dam; however, the asphalt surfacing showed some signs of deterioration. No depressions or cracks indicating a settlement of the embankment were apparent. The variation in elevation across the top of dam did not appear to be due to an instability of the embankment. No significant deviation in the horizontal alignment was apparent, except for the change in the alignment of the dam, which appears to have been constructed this way. According to Mr. Shy, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope of the dam is not protected by riprap; consequently, some damage due to wave action was observed on the slope. Scarps up to one foot high were observed along the slope at the normal water surface level (see Photo 1). A small bench was observed just below the normal water surface level, which also appeared to have been formed due to wave action. A surficial layer of rock was seen on the slope, but it provided little or no protection. The portion of the slope above the normal water surface was adequately protected against surface runoff by a good vegetative cover ranging from tall grass to a few small bushes. No trees were observed on the upstream slope. The angle of the upstream slope above the normal water surface level did not appear to be indicative of the slope angle below the normal water surface level, which appeared to be flatter. Some shallow surface sloughs were observed on the slope; however, no major depressions, bulges or cracking indicating an instability of the embankment or foundation were apparent on the slope.

The downstream slope supports mostly a grass covering with some small bushes (see Photo 3). The grass cover in some areas is sparse; however, no erosion due to surface runoff was seen. No trees were growing on the slope; however, several small saplings were observed on slope. A few large trees were also observed growing along the downstream, right abutment/embankment contact. Several small tree stumps were observed on the slope. According to Mr. Sells, the trees were removed recently from the slope and piled along the toe of the dam. Several shallow surface sloughs were seen on the slope. The largest depression observed was approximately 20 feet wide and less than one foot deep. The sloughing of the slope did not appear to have been due to recent movements and does appear to be inactive at this time. No bulges, depressions or cracks indicative of a major slope movement were apparent. No seepage was observed on the embankment or along the toe of the dam. It was unknown if any seepage was exiting downstream of the dam due to the backwater of Clear Lake Dam (Mo. 30437).

The right abutment slopes moderately upward from the dam and the left abutment is at approximately the same elevation as the top of dam. No instabilities or seepage were observed on the right abutment. No erosion felt to be detrimental to the safety of the dam or abutment was apparent on the right abutment. The only problem observed on the left abutment, which could be detrimental to the dam and abutment, was the erosion in the spillway discharge channel, as described in Section 3.1d.

According to Mr. Shy, there has been some muskrat activity in the reservoir in the past; however, the muskrats are annually trapped. No evidence of burrowing animals was apparent on either the embankment or the abutments.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Joachim Creek in the Salem Plateau section of the Ozark Plateaus Physiographic Province. Deep dissection of topography by major streams is one of the important characteristics of the Salem Plateau section. There is a wide distribution of dolomites and limestones in the Salem Plateau. Cuestaform topography is exhibited in this plateau section consisting of two major escarpments, namely the Crystal Escarpment and Burlington Escarpment. Deep dissection in dolomites and limestones is a major factor in the development of many springs in this area. A major component of surface discharge of water to the regional drainage is contributed by these springs.

The topography in the vicinity of the damsite is hilly with V-shaped valleys. Elevations of the ground surface range from 1020.0 feet above M.S.L. nearly 1.6 miles southwest of the damsite to 739.0 feet above M.S.L. at the damsite. The reservoir slopes are generally from 18 to 22 degrees from horizontal. The reservoir slopes are stable and the reservoir appears to be watertight. The area near the damsite is covered with residual soil deposits consisting of a reddish-brown and orangey-brown mottled, moderately plastic, silty clay with some fine sand and occasional rock fragments less than 1/4 inch in size.

The regional bedrock geology beneath the residual soil deposits in the damsite area as shown on the Geologic Map of Missouri (1979) (see Plate 6) are of the Ordovician age rocks consisting of Decorah Formation, St. Peter Sandstone, Powell Dolomite, Cotter Dolomite, Roubidoux Formation, and Gasconade Dolomite; and the Cambrian age rocks consisting of Eminence Dolomite, Potosi Dolomite, Lamotte Sandstone, and Franconia and Bonneterre Formations. The predominent bedrock underlying the residual soil deposits in the vicinity of the damsite are the Ordovician age rocks consisting of Powell Dolomite and Roubidoux Formation.

Outcroppings of Ordovician Powell Dolomite (light, brownish-gray, fine-grained, very hard, moderately bedded, slightly weathered dolomite) are exposed in the discharge channel of the spillway (see Photo 9). Moderate solution activity and secondary sedimentary internal structures (such as spherulites and concretions) were observed in the rock outcroppings.

No active faults have been identified at the damsite. The closest trace of a fault to the damsite is the Ste. Genevieve fault system. The Ste. Genevieve fault had its last movement in the post-Pennsylvanian time and thus, should have no effect on the damsite.

No boring logs or construction reports are available that would indicate foundation conditions encountered during construction. Based on the visual inspection and conversations with Mr. Shy, the embankment probably rests on the bedrock of the Ordovician Powell Dolomite with the core trench excavated to the bedrock. The spillway rests on a thin layer of residual soils, which overlays the Powell Dolomite bedrock.

(2) Project Soils

According to the "Missouri General Soil Map and Soil Association Description" published by the Soil Conservation Service, the materials in the general area of the dam belong to the soil series of Union-Goss-Gasconade-Peridge in the Ozark Border Association. The soils are basically formed from loess deposits and weathered bedrock. These soils vary from a slowly permeable silty clay to moderately permeable silt loam.

Material removed from the embankment slopes was a reddish-brown, moderately plastic, silty clay with traces of fine to medium sand. Based upon the Unified Soil Classification System, the soil would be classified as a CL. This is an impervious soil type, which generally has the following characteristics: a coefficient of

permeability less than one foot per year, medium shear strength, and a high resistance to piping. This soil type also has a high resistance to erosion under low velocity flow; however, excessive erosion can occur during the high velocity flows that can be expected when the dam is overtopped.

d. Appurtenant Structures

(1) Spillway

The concrete of the weir appeared sound with no damage evident; however, some repair work had been done recently at the left end of the weir (see Photo 4). The vertical faces of the weir were irregular indicating sloppy formwork at the time of placement. Water was flowing over the weir on the day of inspection; therefore, it was impossible to determine if there was any leakage between the weir and spillway slab. The concrete surface of the channel is spalling in the area where vehicles cross the spillway. Some of these damaged areas are two to three inches deep and reinforcement is exposed (see Photo 7). Several concrete patches were also seen in this area of the channel. There are numerous transverse cracks in the channel particularly in the lower half, although none exhibit separation of more than a quarter of an inch. Reinforcement was exposed in several other locations; however, the exposed reinforcement was not due to concrete damage but to sloppy placement. A considerable amount of repair work has been done at the downstream end of the spillway slab, as evidenced by dumped concrete in the area. The concrete in this region appeared stable; however, seepage, estimated at between five and ten gallons per minute, was observed flowing from under the right edge of the downstream end of the spillway slab (see Photo 8). The discharge of the seepage was clear; however, sounds created by tapping the concrete slab indicated that there might be some hollow spots between the slab and the foundation, indicating that undermining of the slab possibly might have occurred. The discharge channel invert appeared stable; however, the side slopes were unprotected and near vertical due to erosion (see Photo 6).

(2) Outlet Works

No low-level outlet or outlet works were provided for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of the inspection was 739.0 feet above M.S.L. The reservoir has a normal water surface elevation of 739.0 feet above M.S.L. and a surface area of 23 acres at the normal water surface level.

The rim appeared to be stable with no erosional or stability problems observed (see Photo 10). The land around the reservoir slopes gently upward from the reservoir rim and is mostly wooded with grass-covered slopes. Several houses are built around the reservoir rim. No evidence of excessive siltation was observed in the reservoir on the day of the inspection.

Two dams and reservoirs are located upstream of Sunrise Lake and were considered to be large enough to have an effect on the flood routing evaluation for Sunrise Lake Dam, as further discussed in Section 5 (see Plate 2). The two dams are named as follows: Big Lake Dam (Mo. 30457); and Little Lake Dam (Mo. 30456).

f. Downstream Channel

There is no downstream channel. The spillway discharges directly into the reservoir of Clear Lake Dam (Mo. 30437).

3.2 Evaluation

The visual inspection did not reveal any conditions which were felt to constitute an unsafe condition at this time; however, the following conditions were observed which could adversely affect the dam in the future and will require maintenance within a reasonable period of time.

1. The seepage under the spillway slab constitutes a hazard to the stability of the spillway and the dam. This seepage could undermine the spillway slab causing it to fail, thus jeopardizing the safety of the dam.

2. The spalling concrete in the channel does not appear to affect the structural integrity of the spillway at this time; however, further weathering can only jeopardize the structure.

3. The transverse cracks in the spillway channel did not appear to indicate an unsafe condition; however, the cracks do provide an avenue by which water can flow under the spillway slab. Water flowing under the spillway slab could undermine it, resulting in an unsafe condition.

4. The unprotected banks of the spillway discharge channel do not presently represent a hazard to the spillway; however, the condition is unstable and the side slopes could erode to the point where the foundation of the spillway channel is jeopardized. This also jeopardizes the safety of the dam and abutment.

5. The erosion due to wave action on the upstream slope does not appear to affect the stability of the dam in its present condition. However, continual erosion of the slope can only be detrimental to the structural integrity of the dam.

6. The brush and saplings observed on the embankment slopes pose a potential danger to the safety of the dam, if continual growth is allowed. The large trees observed along the downstream, right abutment/embankment contact also endanger the safety of the dam. Depending upon the extent of the root system, the roots of large trees present possible paths for piping through the embankment. The root systems can also do damage to the embankment from being uprooted by a storm. Periodical maintenance of the grass cover is also recommended.

7. The shallow surface sloughs observed on the embankment slopes did not appear to indicate a major instability of the embankment. Nevertheless, further sloughing of the slopes could be detrimental to the structural integrity of the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

Sunrise Lake Dam is used to impound water for recreational use as a private lake. There are no specific procedures that are followed for the operation of the dam. The water level in the reservoir is allowed to remain as high as possible. The water surface elevation is controlled by rainfall, runoff, evaporation, seepage, and the crest elevation of the spillway weir.

4.2 Maintenance of Dam

The maintenance of the dam appears to be inadequate. The downstream slope is covered with grass, bushes, saplings, and a few large trees along the right abutment contact. According to Mr. Sells, the Property Owners Association had recently removed three-fourths of the trees growing on the dam slopes. The association also mows the grass on the embankment. No riprap protection is provided on the upstream slope of the dam.

Areas of the concrete spillway channel showed signs of uncontrolled cracking. Some of the concrete spillway slab has spalled, exposing reinforcement. Portions of the spillway slab have been patched with concrete.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam.

4.4 Description of Any Warning System in Effect

The inspection team is not aware of any warning system in use at the damsite, such as an electrical warning system or a manual notification plan.

4.5 Evaluation

The maintenance at Sunrise Lake Dam appears to be inadequate; however, the dam does not appear to be neglected. It is recommended that the remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

No hydrologic and hydraulic design data are available for Sunrise Lake Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of the dam were prepared from field notes and sketches prepared during the field inspection. The reservoir elevation-area data were based on the U.S.G.S. Vineland, Missouri Quadrangle topographic map (Advance Print, 7.5 minute series). The spillway and overtop release rates and the reservoir elevation-area data are presented in Appendix B.

The hydrologic soil group of the watershed was determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication "Hydrometeorological Report No. 33" (April 1956). The 100-year and the 10-year floods were derived from the 100-year and the 10-year rainfalls, respectively, of Ste. Genevieve, Missouri.

b. Experience Data

Records of reservoir stage or spillway discharge are not maintained for this site. However, according to Mr. Shy, the maximum reservoir level was approximately 18 inches above the crest of the spillway.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood and one-half of the Probable Maximum Flood, which is considered to be the appropriate spillway design flood for this dam, when routed through the reservoir, resulted in overtopping of the dam. The peak inflows of the PMF and one-half of the PMF are 12,707 cfs and 5,245 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 11,416 cfs and 4,233 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 1,185 cfs. The PMF overtopped the dam by 4.62 feet and one-half of the PMF overtopped the dam by 2.66 feet. The total duration of flow over the dam is 6.2 hours during the occurrence of the PMF and 4.1 hours during one-half of the PMF. The spillway/reservoir system of Sunrise Lake Dam is capable of accommodating a flood equal to approximately 20 percent of the PMF just before overtopping the dam and will also accommodate the one-percent chance flood (100-year flood) without overtopping the dam. The analysis of Sunrise Lake Dam included the hypothetical breach of the two upstream dams (Big Lake Dam (Mo. 30457), and Little Lake Dam (Mo. 30456)) for those floods during which the dams were overtopped.

The surface soils on the embankment consist of a silty clay. The top of dam is covered by an asphalt road and the downstream slope has a good cover of grass. However, the dam will be overtopped by over 2.5 feet during the occurrence of one-half of the PMF, which can cause severe erosion to the embankment due to the high velocity of flow on its downstream slope and could lead to the eventual failure of the dam. The concrete lining of the spillway channel should resist excessive erosion during the occurrence of

one-half of the PMF; however, the earth-cut portion of the spillway discharge channel will be susceptible to further erosion due to high velocity flows.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends less than three miles downstream of the dam. Located within the damage zone are at least nine dwellings, one building, one downstream dam (Clear Lake Dam (Mo. 30437)), and a county highway (Highway V), which parallels Joachim Creek. A failure of the dam could also cause the failure of the downstream dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection, except for the shallow surface sloughs on the embankment slopes. The surface sloughs did not appear to be serious enough to constitute an unsafe condition at this time and the stability of the dam does not appear to be in jeopardy. The erosion on the upstream slope due to wave action does not appear to endanger the structural stability of the embankment in its present condition; however, continual erosion of the slope could be detrimental to the embankment. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The structural stability of the spillway is questionable. Seepage was observed discharging from under the spillway slab at the downstream end, at a rate estimated to be between five and ten gallons per minute. The present amount of undermining due to the seepage is unknown; however, the very fact that water is flowing under the spillway slab places its stability in a rather untenable position. Transverse cracks were observed in the lower half of the spillway indicating that possible structural stresses have been present in the slab. The structural stability of the eroded side slopes of the spillway discharge channel is also in jeopardy. The spillway is unobstructed and should be able to operate properly.

b. Design and Construction Data

No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

No operating records are available relating to the stability of the dam or the spillway. The water level on the day of inspection was at the normal pool elevation.

d. Post Construction Changes

No post construction changes to the embankment are known to exist that will affect the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2, as defined in the "Recommended Guidelines for Safety Inspection of Dams" as prepared by the Corps of Engineers (see Plate 9). Seismic Zone 2 is characterized by a moderate earthquake hazard. An earthquake of the magnitude that would be expected in Seismic Zone 2 should not cause significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite. The maximum recorded historic magnitude earthquake in the immediate vicinity of the damsite was the July 21, 1967, event of magnitude 4.4 located at a distance of approximately 36 miles southeast of the damsite. This event cannot be correlated with known tectonic structure and is considered to probably be

related to the release of accumulated residual strain along a buried pre-Quaternary fault. The attenuation of this event to the damsite would produce a peak ground acceleration of less than 0.05g which would not produce a significant seismic impact on the dam.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and the visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Sunrise Lake Dam is found to be "Seriously Inadequate". The spillway/reservoir system will accommodate about 20 percent of the PMF without overtopping the dam. If the dam is overtopped, the safety of the embankment would be in jeopardy due to the susceptibility of the embankment materials to erosion. High velocity of flow on the downstream slope of the dam could cause excessive erosion and eventually lead to a failure of the dam. The spillway could also receive further damage during the occurrence of one-half of the PMF, especially in the earth-lined portions of the discharge channel.

The overall condition of the dam appears to be fair; however, some items of concern were noted that will require attention. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment, however, appears to have performed satisfactorily without failure since its construction. The dam has never been overtopped, according to Mr. Shy, and no evidence indicating the contrary was observed. The safety of the dam can only be improved if the deficiencies described in Section 3.2 are properly corrected as described in Section 7.2b.

b. Adequacy of Information

The conclusions presented in this report are based upon field measurements, past performance and the present condition of the dam. Documented information on the design hydrology, hydraulic design, operation, and maintenance of the dam was not available. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

c. Urgency

The items recommended in paragraph 7.2a, regarding gaining additional spillway capacity, should be pursued on a high priority basis. The remedial measures recommended in Paragraph 7.2b should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the spillway capacity to pass one-half of the PMF, without overtopping the dam. The spillway should also be adequately protected to prevent excessive erosion during the occurrence of one-half of the PMF.

2. Increase the height of the dam in order to pass one-half of the PMF without overtopping the dam; an investigation should also include studying the effects that increasing the height of the dam would have on the structural stability of the present embankment. The overtopping depth during the occurrence of one-half of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. The source of seepage flowing under the spillway slab should be found and the seepage stopped.

2. The areas of spalling and the cracks in the concrete slab of the spillway channel should be repaired.

3. The side slopes of the spillway discharge channel should be stabilized and protected from erosion.

4. The wave erosion on the upstream slope should be properly repaired and the slope protected from further damage.

5. The brush and saplings on the embankment slopes should be removed from the embankment and regrowth prevented. The grass cover on the embankment, especially on the downstream slope, should be periodically maintained. The grass cover should be retained on the downstream slope to protect it from erosion due to surface runoff and to prevent excessive erosion in the event the dam is overtopped. The trees along the downstream, right abutment/embankment contact should also be removed. Removal of large trees should be under the guidance of an engineer experienced in the design and construction of earth dams. Indiscriminate clearing could jeopardize the safety of the dam.

6. The embankment slopes should be monitored to detect any further sloughing of the slopes, which may be detrimental to the stability of the dam. Any major movements of the slope should be investigated further by a professional engineer experienced in the design and construction of earth dams and repairs made as necessary.

7. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

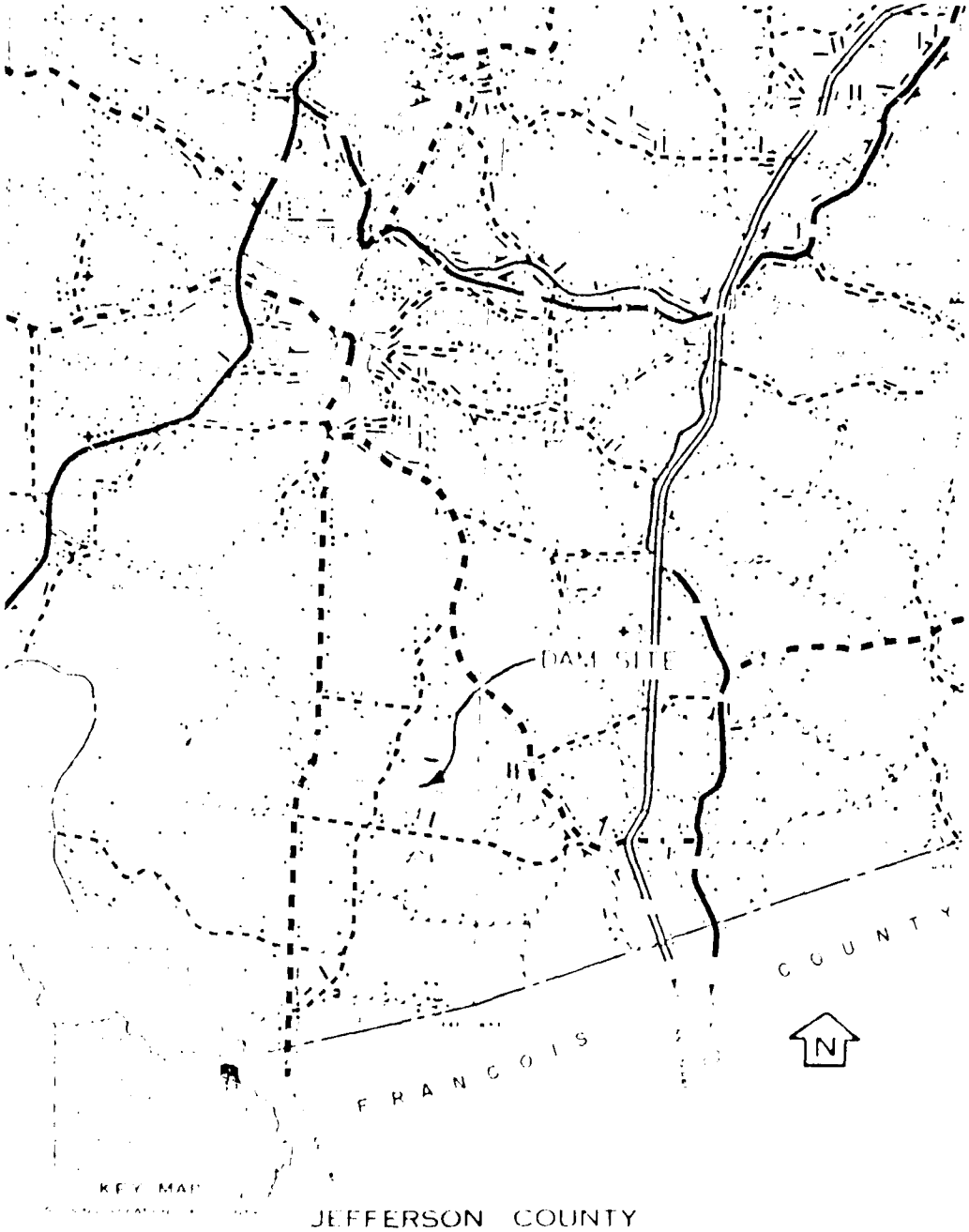
8. The owner should initiate the following programs:

   (a) Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

   (b) Set up a maintenance schedule and log all repairs and maintenance.

PLATES

PLATE 1

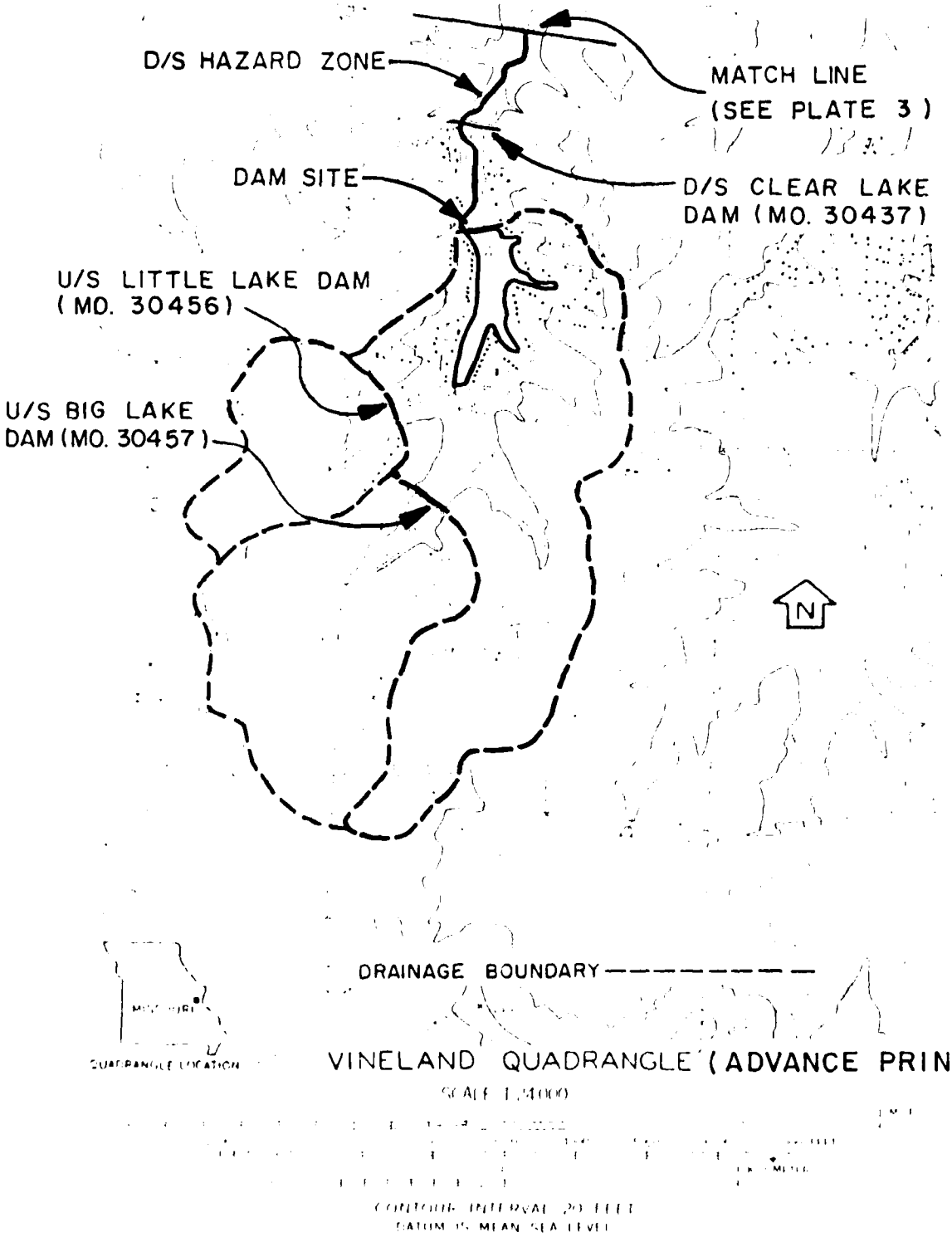


JEFFERSON COUNTY

SCALE

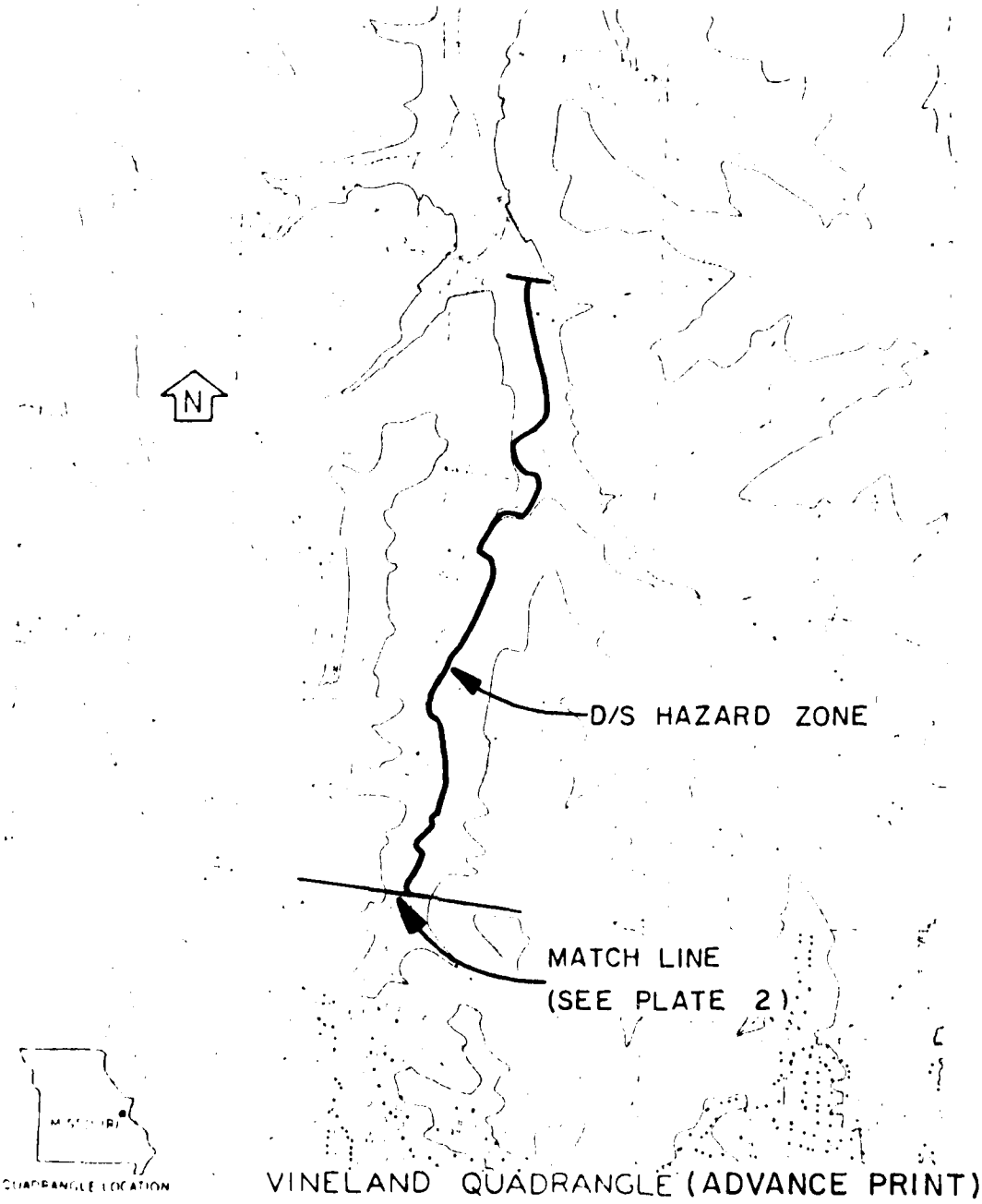
SUNRISE LAKE DAM (MO. 31190)
LOCATION MAP

PLATE 2



SUNRISE LAKE DAM (MO.31190)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 1 OF 2)

PLATE 3



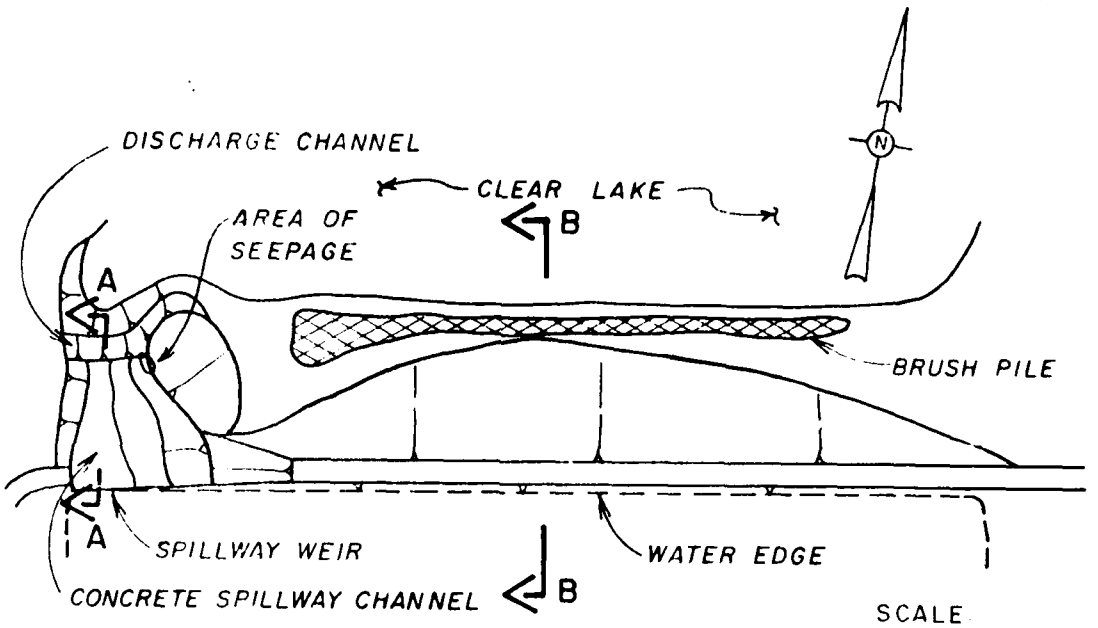
VINELAND QUADRANGLE (ADVANCE PRINT)

SCALE 1:24000

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL

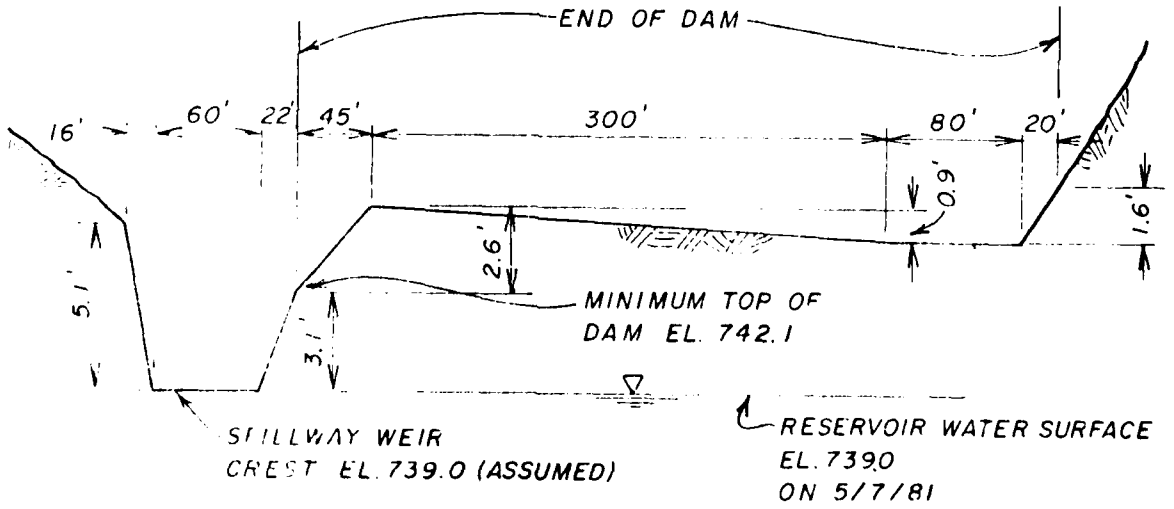
SUNRISE LAKE DAM (MO. 31190)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 2 OF 2)

PLATE 4



PLAN

SCALE:
HORIZ. 1" = 100'

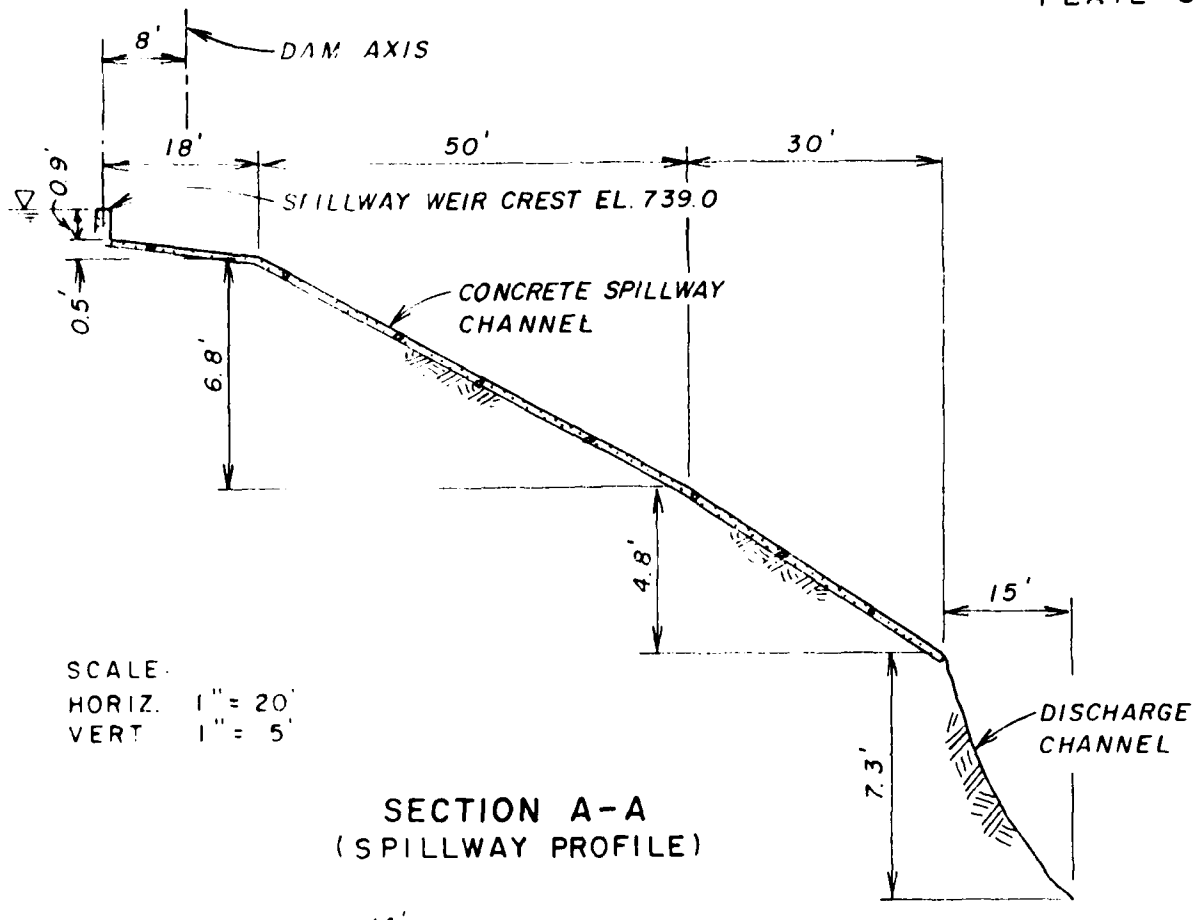


ELEVATION

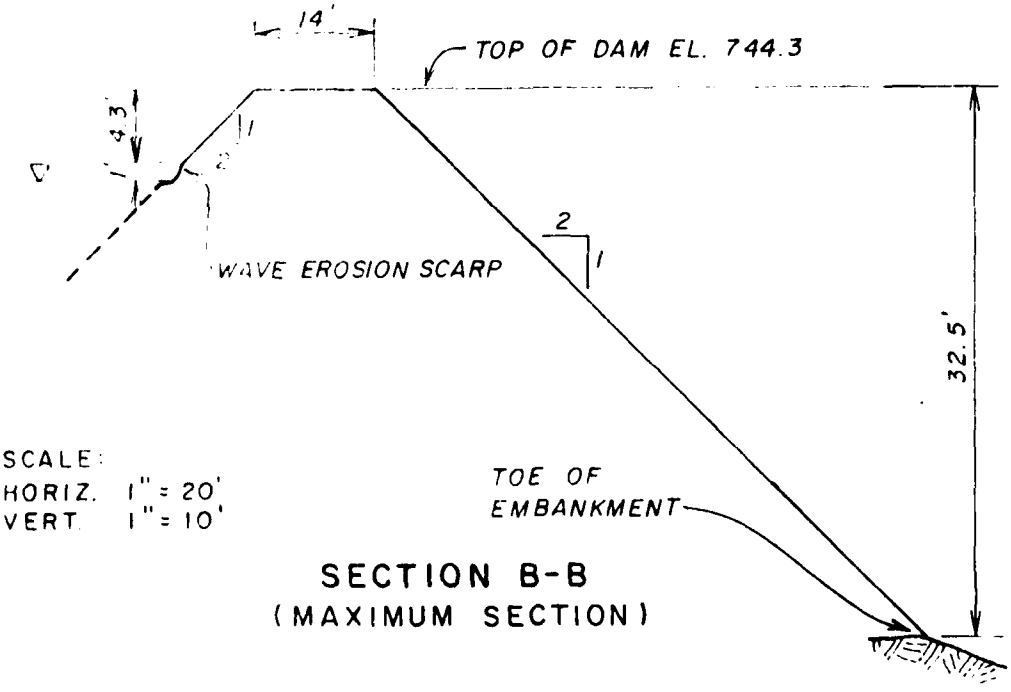
SCALE:
HORIZ 1" = 100'
VERT 1" = 5'

SUNRISE LAKE DAM (MO. 31190)
PLAN AND ELEVATION
(SHEET 1 OF 2)

PLATE 5



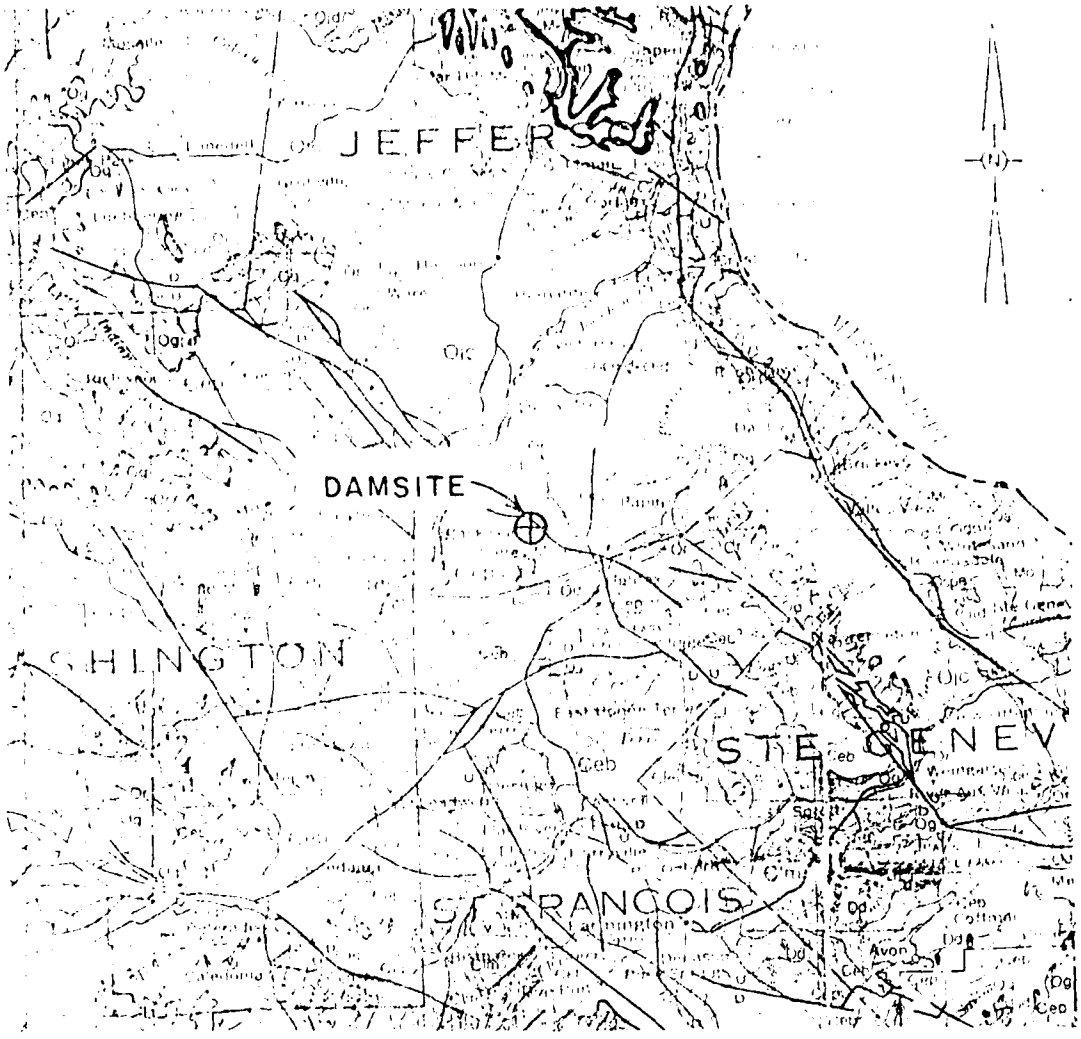
SECTION A-A
(SPILLWAY PROFILE)



SECTION B-B
(MAXIMUM SECTION)

SUNRISE LAKE DAM (MO. 31190)
SPILLWAY PROFILE AND MAXIMUM SECTION
(SHEET 2 OF 2)

PLATE 6



SCALE

0 10 20 30 40 Miles

(1) LOCATION OF DAM

NOTE: LEGEND FOR THIS MAP IS ON PLATES 7 AND 8.

REFERENCE

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP OF SUNRISE LAKE DAM

SUNRISE LAKE DAM
PLATE 7
SHEET 1 OF 2

LEGEND

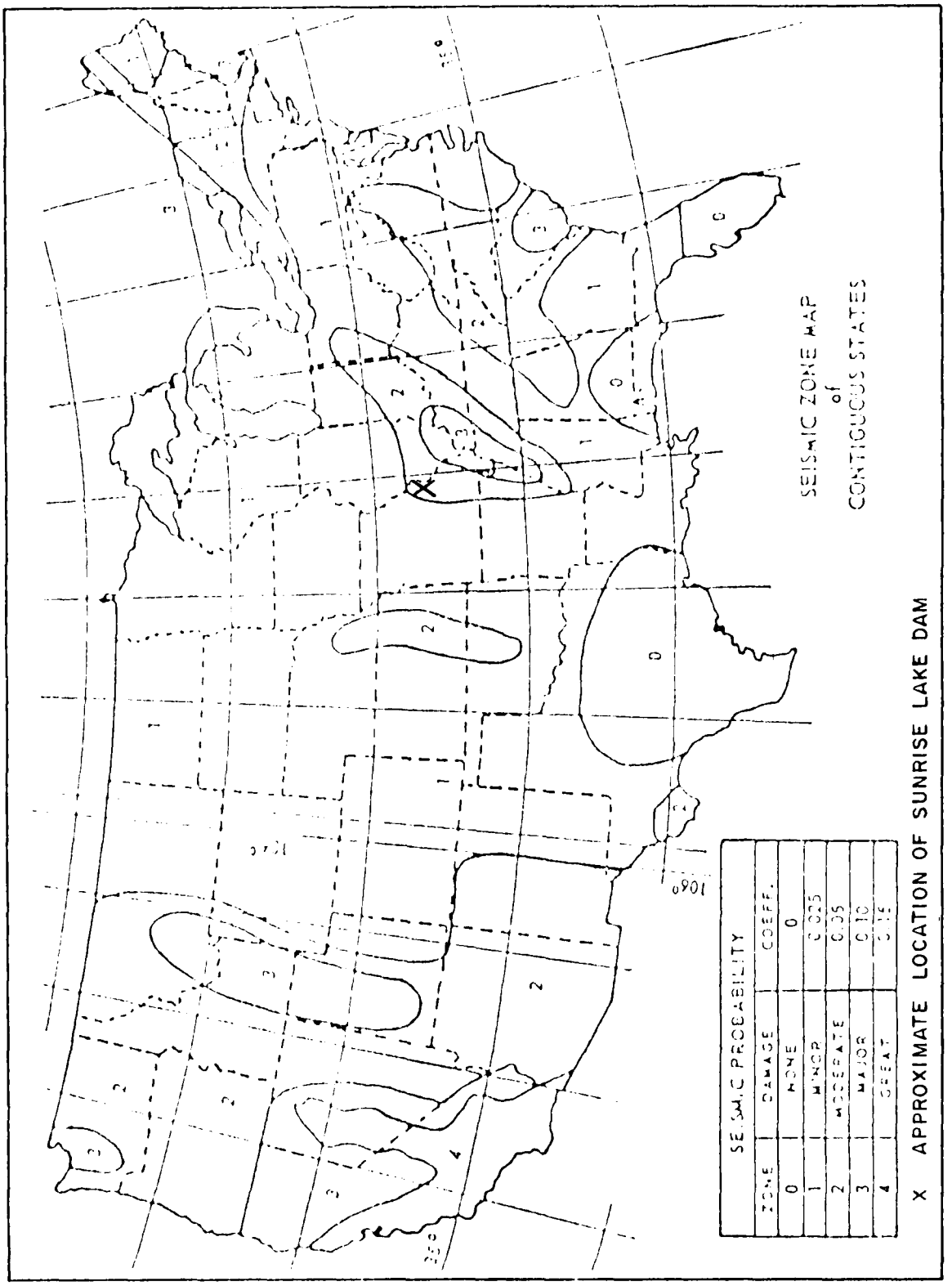
PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
MISSISSIPPIAN	Mo	KEOKUK - BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	UNDIFFERENTIATED CHOUTEAU GROUP: LIMESTONE
	Mk	HANNIBAL FORMATION: SHALE AND SILTSTONE
DEVONIAN	Dd	DIATREMES, KIMBERLITES, CARBONATITES
ORDOVICIAN	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTONE
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Ospe	ST. PETER SANDSTONE, EVERTON FORMATION
	Ojd	JOACHIM DOLOMITE
	Ojc	POWELL DOLOMITE, COTTER DOLOMITE
	Or	ROUBIDOUX FORMATION: INTERBEDS OF CHERTY LIMESTONE AND SANDSTONE
	Og	GASCONADE DOLOMITE

SUNRISE LAKE DAM
PLATE 8
SHEET 2 OF 2

LEGEND

PERIOD	SYMBOL	DESCRIPTION
CAMBRIAN	Cep	EMINENCE DOLOMITE, POTOSI DOLOMITE
	Cfb	FRANCONIA AND BONNETERRE FORMATION: INTERBEDDED LIMESTONE, CHERTY LIMESTONE, DOLOMITE AND SILTSTONE
	Clm	LAMOTTE SANDSTONE
PRECAMBRIAN	I	ST. FRANCOIS MOUNTAINS INTRUSIVE
	V	ST. FRANCOIS MOUNTAINS VOLCANIC
	U / D	NORMAL FAULT
	U / D	INFERRED FAULT
	U =	UPTHROWN SIDE; D = DOWNTHROWN SIDE

PLATE 9


SEISMIC ZONE MAP
of
CONTIGUOUS STATES
X APPROXIMATE LOCATION OF SUNRISE LAKE DAM
SEISMIC PROBABILITY
ZONE
DAMAGE
COEFF.
0
NONE
0
1
MINOR
0.025
2
MODERATE
0.05
3
MAJOR
0.10
4
GREAT
0.15

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

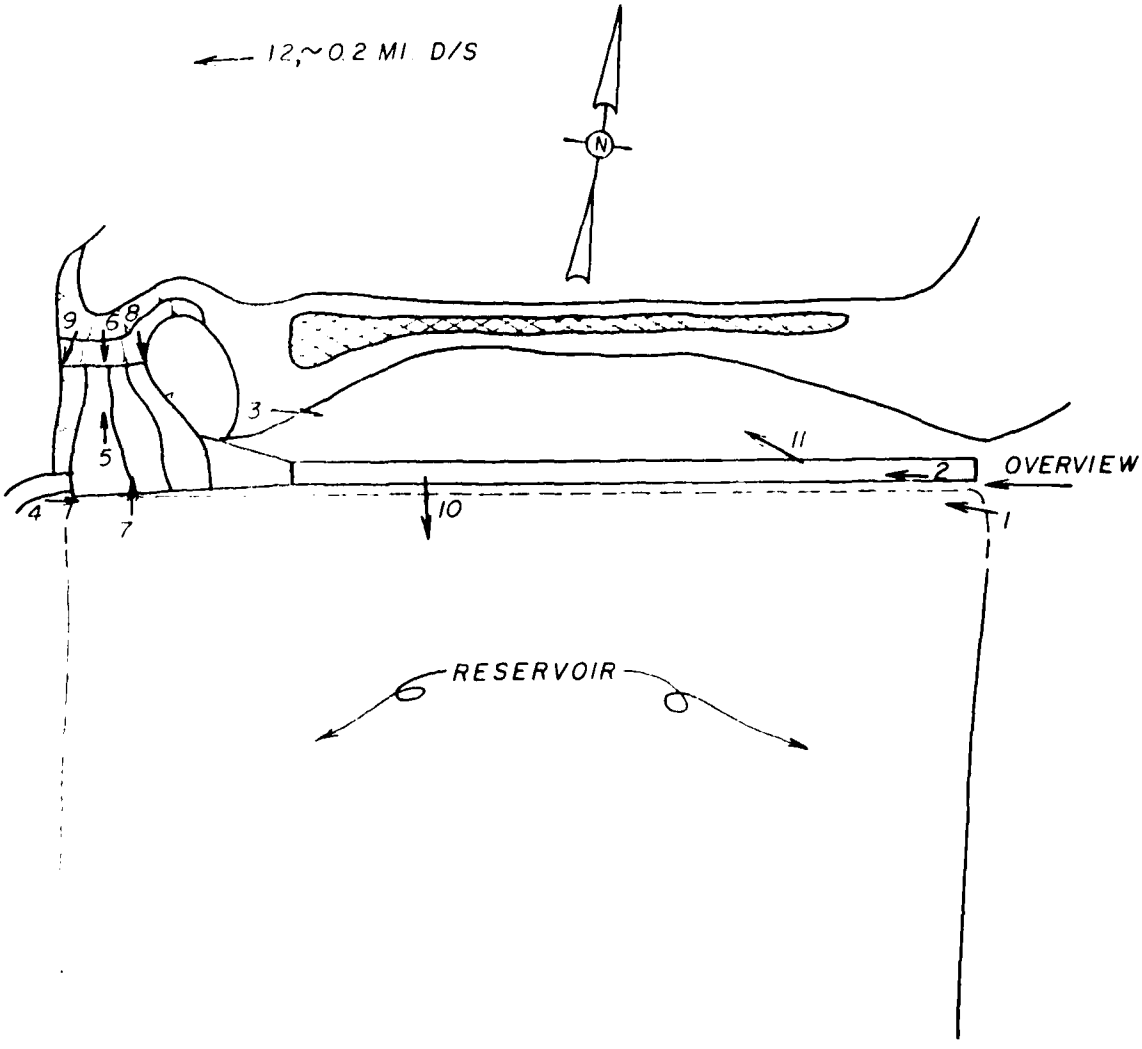


PHOTO INDEX
FOR
SUNRISE LAKE DAM

Photo 1 - View of the upstream slope from the right abutment.

Photo 2 - View of the top of dam from the right abutment.

Photo 3 - View of the downstream slope from the left abutment.

Photo 4 - View of the weir at the spillway control section from the left abutment.

Photo 5 - View of the spillway channel looking downstream. Note cracks in concrete slab in the foreground and the dwelling in the background.

Photo 6 - View of the spillway discharge channel looking upstream at the spillway channel outfall.

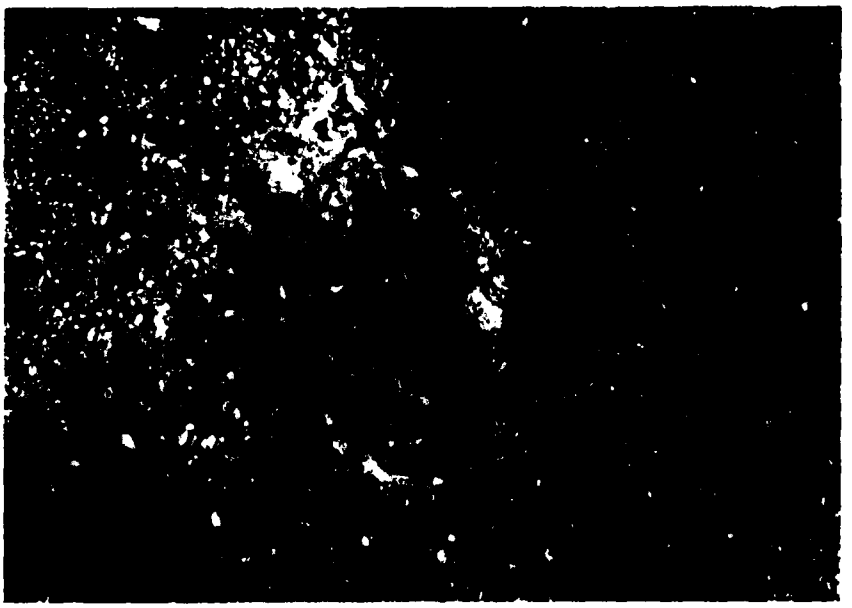


Photo 7 - Close-up view of spalling concrete and exposed reinforcement of the spillway slab near the control section.

Photo 8 - Close-up view of seepage flowing from under the right side of the spillway channel.

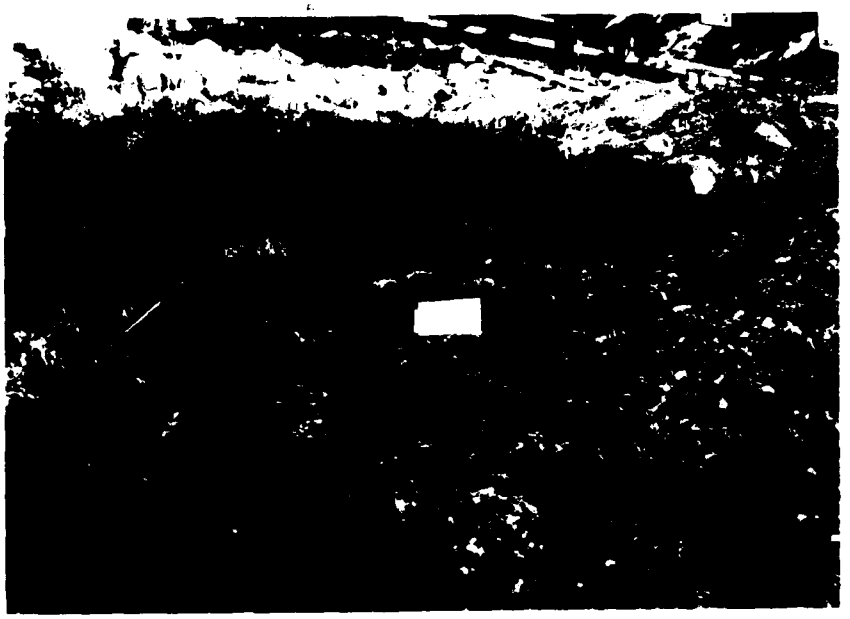


Photo 9 - Close-up view of an outcropping of slightly weathered dolomite in the spillway discharge channel.

Photo 10 - View of the reservoir and rim.

Photo 11 - View of dwellings in the downstream hazard zone looking across Clear Lake from the top of Sunrise Lake Dam.

Photo 12 - View of a dwelling in the downstream hazard zone looking from the top of Clear Lake Dam.

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

SUNRISE LAKE DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph procedures and the HEC-1DB computer program are used to develop the inflow hydrographs. The hydrologic inputs are as follows:

   (a) 24-hour Probable Maximum Precipitation from Hydrometeorological Report No. 33, and 24-hour 100-year rainfall and 24-hour 10-year rainfall of Ste. Genevieve, Missouri.

   (b) Drainage area = 1.31 square miles. (total drainage area)
   = 0.70 square miles. (excluding the drainage areas of the U/S dams)

   (c) Lag time = 0.29 hours (for Sunrise Lake subarea alone).

   (d) Hydrologic Soil Group:
   Soil Group "C".

   (e) Runoff curve number:
   CN = 73 for AMC II and CN = 87 for AMC III.

2. Flow rates through the spillway are based on assuming critical depth at the weir crest. Flow rates over the dam are based on the broad-crested weir equation $Q = CLH^{3/2}$ and critical depth assumption, in accordance with the procedures used in the HEC-1 computer program.

3. The spillway and the dam overtop rating curves are hand calculated and combined as shown on pages B-5 and B-6. This combined rating curve is input into HEC-1DB on the Y4 and Y5 cards. The $L and $V cards are, therefore, not used.

4. Floods are routed through Sunrise Lake to determine the capability of the spillway. The analysis of Sunrise Lake Dam included the hypothetical breach of the two upstream dams for those floods during which the respective dams were overtopped.

5. Critical assumptions concerning channel flow and breach parameters were made in accordance with the hydrologic and hydraulic guidelines provided by the St. Louis Corps of Engineers.

EC1-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. 1 OF 1

DAM NAME: Sunrise Lake Dam (MO. 31190) — JOB NO. 1283

UNIT HYDROGRAPH PARAMETERS — BY JFK DATE 5/12/81

1) DRAINAGE AREA, $A = 0.70$ sq. mi = (451.0 acres)

2) LENGTH OF STREAM, $L = (3.9'' \times 2000' = 7800') = 1.48$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 990$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 739$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 890$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 750$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = 0.024$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = [11.9 \times 1.48^3/(251)]^{0.385} = 0.49$ hr

B) BY VELOCITY ESTIMATE,

SLOPE = 2.4% $\Rightarrow$ AVG. VELOCITY = 3 fps

$t_c = L/V = 7800'/3$ fps $\times$ hr/3600s $= 0.72$ hr

USE $t_c = 0.49$ hr

9) LAG TIME, $t_l = 0.6\, t_c = 0.29$ hr

10) UNIT DURATION, $D \leq t_l/3 = 0.097$ hr < 0.166 hr.

USE $D = 0.083$ hr

11) TIME TO PEAK, $T_p = D/2 + t_l = 0.33$ hr

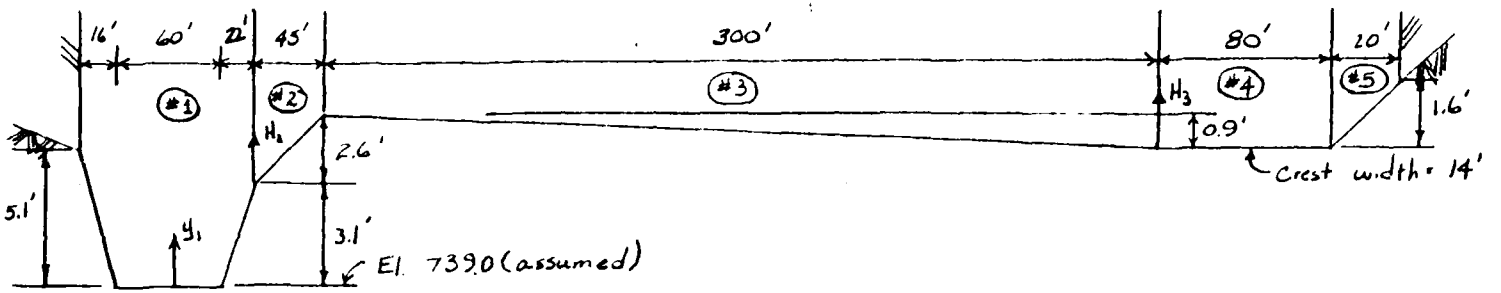
12) PEAK DISCHARGE,

$q_p = (484 \times A)/T_p = 484 \times 0.70/0.33 = 1025$ cfs

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

Dam Safety Inspection - Missouri — SHEET NO. 1 OF 1
Suncrise Lake Dam (Mo. 31190) — JOB NO. 1283
Reservoir Elevation - Area Data — BY JFK DATE 5/15/81

Elevation (Ft, MSL)	Area (acres)	Remarks
715	0	Estimated Streambed U/S at dam
720	1.5	Interpolated
730	7.5	Interpolated
739	23.0	Spillway Crest (assumed)
740	27.5	Measured from USGS 7.5' Quad
742.1	32.0	Minimum Top of Dam
750	42.0	Interpolated
760	51.5	Measured from USGS 7.5' Quad



for Section #1*: $Q_1 = \sqrt{A_1^3 g / T_1}$; for $0 < y_1 \leq 3.1$

$A_1 = 60.0 y_1 + 5.1 y_1^2$
$T_1 = 60.0 + 10.2 y_1$

for $3.1 < y_1 \leq 5.1$

$A_1 = 82.0 y_1 + 1.6 y_1^2 - 34.1$
$T_1 = 82.0 + 3.1 y_1$

for $5.1 < y_1$

$A_1 = 98.0 y_1 - 74.9$
$T_1 = 98.0$

W.S.EL. = $739.0 + y_1 + V_1^2/2g$

for Section #2*: $Q_2 = \sqrt{A_2^3 g / T_2}$; for $0 < y_2 \leq 2.6$

$y_2 = 4/5 H_2$
$A_2 = 8.7 y_2^2$
$T_2 = 17.3 y_2$

for $2.6 < y_2$; H_2 = W.S.EL. - 742.1

$y_2 = 2/3(H_2 + 0.7)$
$A_2 = 45.0 y_2 - 58.5$
$T_2 = 45.0$

for Section #3*: $Q_3 = \sqrt{A_3^3 g / T_3}$; for $0 < y_3 \leq 0.9$

$y_3 = 4/5 H_3$
$A_3 = 166.7 y_3^2$
$T_3 = 333.3 y_3$

for $0.9 < y_3$; H_3 = W.S.EL. - 743.8

$y_3 = 2/3(H_3 + 0.2)$
$A_3 = 300.0 y_3 - 135.0$
$T_3 = 300.0$

for Section #4: $Q_4 = C L H_3^{1.5}$

for Section #5*: $Q_5 = \sqrt{A_5^3 g / T_5}$; for $0 < y_5 \leq 1.6$

$y_5 = 4/5 H_3$
$A_5 = 6.3 y_5^2$
$T_5 = 12.5 y_5$

for $1.6 < y_5$

$y_5 = 2/3(H_5 + 0.4)$
$A_6 = 20.0 y_5 - 16.0$
$T_5 = 20.0$

* critical depth assumed

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

Dam Safety Inspection - Missouri — SHEET NO 2 OF 3

Sunrise Lake Dam (Mo. 31190) — JOB NO. 1283

Spillway and Overtop Rating Curve — BY JFK DATE 5/15/81

Y_1	A_1	T_1	V_1	Q_1	W.S EL.	H_2	Y_2	A_2	T_2	Q_2	H_3	Y_3	A_3	T_3	Q_3
0	0	0	0	0	739.0										
0.1	6.1	61.0	1.8	10.8	739.2										
0.3	18.5	63.1	3.1	56.7	739.4										
0.5	31.3	65.1	3.9	123.0	739.7										
0.8	51.3	68.2	4.9	252.3	740.2										
1.0	65.1	70.2	5.5	355.8	740.5										
1.3	86.6	73.3	6.2	534.6	740.9										
1.5	101.5	75.4	6.6	688.6	741.2										
1.8	124.6	78.4	7.2	891.0	741.6										
2.0	140.5	80.5	7.5	1053.1	741.9	0	0	0	0	0					
2.3	165.1	83.5	8.0	1316.7	742.3	0.2	0.16	0.2	2.8	0.4					
2.5	182.0	85.6	8.3	1505.8	742.6	0.5	0.4	1.4	6.9	3.5					
2.8	208.1	88.7	8.7	1809.4	743.0	0.9	0.7	4.5	12.5	15.3					
3.0	226.1	90.7	9.0	2025.0	743.2	1.1	0.9	6.7	15.2	25.2					
3.3	253.6	92.4	9.4	2384.4	743.7	1.6	1.3	14.2	22.2	64.4	0	0	0	0	0
3.5	272.1	93.0	9.7	2641.6	744.0	1.9	1.5	20.0	26.3	98.9	0.2	0.16	4.3	53.3	6.9
4.0	319.0	94.5	10.4	3324.9	744.7	2.6	2.1	37.4	36.0	216.7	0.9	0.7	86.4	240.	294.2
4.5	366.7	96.1	11.1	4063.8	745.4	3.3	2.6	60.0	45.0	393.1	1.6	1.2	230.	300.	1142.8
5.0	415.1	97.7	11.7	4855.8	746.1	4.0	3.1	81.0	45.0	616.7	2.3	1.7	370.	300.	2331.7
5.5	464.1	98.0	12.4	5731.0	746.9	4.8	3.6	105.0	45.0	910.1	3.1	2.2	530	300.	3997.4

W.S.EL.	H_4	C	Q_4	H_5	Y_5	A_5	T_5	Q_5	Q_{TOTAL}
739.0									0
739.2									11
739.4									57
739.7									123
740.2									252
740.5									356
740.9									535
741.2									689
741.6									891
741.9									1053
742.3									1317
742.6									1509
743.0									1825
743.2									2050
743.7	0	0	0	0	0	0	0	0	2749
744.0	0.2	2.97	21.2	0.2	0.16	0.2	2.0	0.3	2769
744.7	0.9	3.03	207.2	0.9	0.7	3.2	9.0	11.0	4054
745.4	1.6	3.04	492.6	1.6	1.3	10.2	16.0	46.5	6139
746.1	2.3	3.06	853.0	2.3	1.8	20.0	20.0	113.5	8771
746.9	3.1	3.08	1343.2	3.1	2.3	30.7	20.0	215.5	12197

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

Dam Safety Inspection - Missouri — SHEET NO. 3 OF 3
Sunrise Lake Dam (Mo. 31190) — JOB NO. 1283
Spillway and Overtop Rating Curve — BY JFK DATE 5/15/81

Check critical depth assumption in spillway:

for $Q_c = 123.$

$y_c = 0.5$
$A = 31.3$
$P_w \cong 65.1$
$n = 0.015$

$$Q_c = \frac{1.49}{n} R^{2/3} S^{1/2} A$$

$$S_c = \left[\frac{Q_c}{1.49} n \frac{1}{A} \frac{1}{R^{2/3}} \right]^2$$

$$S_c = \left[\frac{123.(0.015)}{1.49} \frac{1}{31.3} \frac{1}{\left(\frac{31.3}{65.1}\right)^{2/3}} \right]^2$$

$S_c = 0.004$

mildest slope in channel = $0.5'/18' = 0.028$

$\therefore$ $S_c < S_{channel}$, critical depth assumption is valid.

SUMMARY OF PMF AND ONE-HALF PMF ROUTING

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**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1          A1       DAM SAFETY INSPECTION - MISSOURI
    2          A2          SUNRISE LAKE DAM (MO.31190)
    3          A3          PMF AND ONE-HALF PMF
    4          B     300       0       5       0       0       0       0       0       0       0
    5          B1      5
    6          J       1       2       1
    7          J1      1     .5
    8          K            BIGLK                                           1
    9          K1         RUNOFF CALCULATION FOR BIG LAKE DAM DRAINAGE AREA
   10          M       1       2     .42             .42       1                       1
   11          P              26     100     120     130
   12          T                                                      -1      -87
   13          W2           .14
   14          X                      1
   15          K       1    BIGLK                                      1
   16          K1         ROUTE HYDROGRAPH THROUGH BIG LAKE
   17          Y                              1       1
   18          Y1      1                                       -799      -1
   19          Y4    799   799.2   799.4   799.7   800.1   800.4   800.8   801.1   801.5   801.7
   20          Y4  802.1   802.4   802.8   803.0   803.4   803.7   804.1   804.4   805.1   805.9
   21          Y5      0       4      23      52     110     159     246     315     432     521
   22          Y5    670     780     964    1113    1464    1815    2451    3117    5119    7994
   23          SA      0     1.5     4.5      10    14.5    20.5      27    33.5
   24          SE    770     780     790     799     800   802.9     810     820
   25          SS    799
   26          SD  802.9
   27          SE     10      .5     784       1     799   802.9
   28          K       1    BIGLK                                           1
   29          K1         STREAM ROUTING OF HYDROGRAPH TO SUNRISE LAKE
   30          Y                              1       1
   31          Y1      1
   32          Y6   .08     .045     .08     740     800    2000    .002
   33          Y7      0     800     200     780     360     760     480     740     520     740
   34          Y7    500     760     540     780     340     800
```

```
K         LTTLLK                                                        1
K1          RUNOFF CALCULATION FOR LITTLE LAKE DAM DRAINAGE AREA
M       1       2     .19             .19      1                                   1
P              26     100     120     130
T                                                     -1      -87
W2            .12
X                       1
K       1  LTTLLK                                                       1
K1          ROUTE HYDROGRAPH THROUGH LITTLE LAKE
Y                                1       1
Y1      1                                               -778       -1
Y4    778   778.5   779.1   780.5   781.6   782.5   783.2   783.9   784.5   785.1
Y4  735.6   786.1   786.5   787.0   787.4
Y5      0      50     100     200     300     400     500     600     700     811
Y5    980    1288    1789    2750    3728
$A      0     1.5       4     4.5       6     8.5      15



$E    765     770     778     780   784.7     790     800
$$    778
$D  784.7
$B     10      .5     774       1     778   784.7
K         SNRSLK                                                        1
K1          RUNOFF CALCULATION FOR SUNRISE LAKE DAM DRAINAGE AREA
M       1       2      .7              .7      1                                   1
P              26     100     120     130
T                                                     -1      -87
W2            .29
X                       1
```

```
K       3  SNPSLK                                                          1
K1         COMPINE ROUTED HYDROGRAPHS FROM BIG AND LITTLE LAKES WITH RUNOFF
K       1  SNRSLK                                                          1
K1         ROUTE HYDROGRAPH THROUGH SUNRISE LAKE
Y                                      1       1
Y1      1                                                    -739      -1
Y4    739    739.2   739.4   739.7   740.2   740.5   740.9   741.2   741.6   741.9
Y4  742.3    742.6     743   743.2   743.7     744   744.7   745.4   746.1   746.9
Y5      0       11      57     123     252     356     535     689     891    1053
Y5   1317     1509    1825    2050    2449    2769    4054    6139    8771   12197
$4      0      1.5     7.5      23    27.5      32      42    51.5
$E    715      720     730     739     740   742.1     750     760
$$    739
$D  742.1
K      99
```

SUMMARY OF DAM SAFETY ANALYSIS

1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	799.00	799.00	802.90
STORAGE	97.	97.	160.
OUTFLOW	0.	0.	1039.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	804.77	1.87	200.	4718.	.81	15.77	15.42
.50	803.50	.60	172.	2582.	.48	16.75	15.75

PLAN 1 STATION BIGLK

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
1.00	4192.	749.6	15.92
.50	2379.	747.1	16.75

SUMMARY OF DAM SAFETY ANALYSIS

1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	778.00	778.00	784.70
STORAGE	24.	24.	57.
OUTFLOW	0.	0.	737.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	786.67	1.97	69.	2187.	.65	15.75	15.58
.50	784.15	0.00	54.	642.	0.00	15.92	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	739.00	739.00	742.10
STORAGE	175.	175.	262.
OUTFLOW	0.	0.	1185.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	746.72	4.62	423.	11416.	6.17	15.92	0.00
.50	744.76	2.66	352.	4233.	4.08	16.08	0.00

PERCENT OF PMF ROUTING
EQUAL TO SPILLWAY CAPACITY

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION      JULY 1978
  LAST MODIFICATION  01 APR 80
**********
    1                 AI        DAM SAFETY INSPECTION - MISSOURI
    2                 A2           SUNRISE LAKE DAM (MO.31199)
    3                 A3           PERCENT PMF
    4                 B     300        0        5        0        0        0        0        0       -4        0
    5                 B1      5
    6                 J       1        4        1
    7                 J1    .1      .15      .18       .2
    8                 K             BIGLK                                                    1
    9                 K1         RUNOFF CALCULATION FOR BIG LAKE DAM DRAINAGE AREA
   10                 M       1        2      .42                .42        1                        1
   11                 P               26      100      120      130
   12                 T
   13                 W2              .14                                                  -1      -87
   14                 X                        1
   15                 K       1     BIGLK                                                    1
   16                 K1         ROUTE HYDROGRAPH THROUGH BIG LAKE
   17                 Y                                 1        1
   18                 Y1      1                                                          -799       -1
   19                 Y4    799      799.2    799.4    799.7    800.1    800.4    800.8    801.1    801.5    801.7
   20                 Y4  802.1      802.4    802.8    803.0    803.4    803.7    804.1    804.4    805.1    805.9
   21                 Y5      0        4       23       52      110      159      246      315      432      521
   22                 Y5    670      780      964     1113     1464     1815     2451     3117     5119     7994
   23                 YA      0      1.5      4.5       10     14.5     20.5       27     33.5
   24                 YE    770      780      790      799      800    802.9      810      820
   25                 YI    799
   26                 YD  802.9
   27                 YB     10       .5      784        1      799    802.9
   28                 K       1     BIGLK                                                    1
   29                 K1         STREAM ROUTING OF HYDROGRAPH TO SUNRISE LAKE
   30                 Y                                 1        1
   31                 Y1      1
   32                 Y6    .08     .045      .08      740      800     2000     .002
   33                 Y7      0      800      200      760      360      760      480      740      520      740
   34                 Y7    600      760      640      780      840      800
```

```
K           LTILLK
K1            RUNOFF CALCULATION FOR LITTLE LAKE DAM DRAINAGE AREA           1
M      1        2      .19              .19      1
P              26      100     120      130                                       1
T
W             .12                                        -1      -87
X                       1
K      1    LTILLK
K1          ROUTE HYDROGRAPH THROUGH LITTLE LAKE                     1
Y                                1       1
Y1     1
Y4   778    778.5    779.1    780.5    781.6           -778      -1
Y4 785.6    786.1    786.5    787.0    787.4   782.5   783.2   783.9   784.5   785.1
Y5     0       50      100      200      300     400     500     600     700     811
Y5   980     1286     1789     2750     3726
$A     0      1.5        4      4.5        6     8.5      15


$E   765      770      778      780    784.7     790     800
$$   778
$D 784.7
$B    10       .5      774        1      778   784.7
K          SNRSLK
K1         RUNOFF CALCULATION FOR SUNRISE LAKE DAM DRAINAGE AREA           1
M      1        2       .7               .7      1
P              26      100      120      130                                      1
T
W2            .29                                        -1      -87
X                       1
```

```
K      3  SNRSLK                                                                1
K1        COMBINE ROUTED HYDROGRAPHS FROM BIG AND LITTLE LAKES WITH RUNOFF
K      1  SNRSLK                                                                1
K1        ROUTE HYDROGRAPH THROUGH SUNRISE LAKE
Y                                       1       1
Y1     1                                                       -739      -1
Y4   739    739.2    739.4    739.7    740.2    740.5    740.9    741.2    741.6    741.9
Y4 742.3    742.6      743    743.2    743.7      744    744.7    745.4    746.1    746.9
Y5     0       11       57      123      252      356      535      689      891     1053
Y6  1317     1509     1825     2050     2449     2769     4054     6139     8771    12197
$A     0      1.5      7.5       23     27.5       32       42     51.5
$E   715      720      730      739      740    742.1      750      760
$$   739
$D 742.1
K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	799.00	799.00	802.90
STORAGE	97.	97.	160.
OUTFLOW	0.	0.	1039.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	800.63	0.00	119.	208.	0.00	16.00	0.00
.15	801.19	0.00	128.	333.	0.00	16.00	0.00
.18	801.44	0.00	132.	415.	0.00	16.00	0.00
.20	801.62	0.00	135.	483.	0.00	15.92	0.00

PLAN 1 STATION BIGLK

RATIO	MAXIMUM FLOW,CFS	MAXIMUM STAGE,FT	TIME HOURS
.10	194.	741.3	16.25
.15	307.	742.0	16.25
.18	382.	742.6	16.17
.20	436.	742.9	16.17

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	778.00	778.00	784.70
STORAGE	24.	24.	57.
OUTFLOW	0.	0.	737.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	779.34	0.00	29.	117.	0.00	15.92	0.00
.15	780.06	0.00	32.	168.	0.00	15.92	0.00
.18	780.45	0.00	34.	199.	0.00	15.92	0.00
.20	780.76	0.00	36.	223.	0.00	15.92	0.00

SUMMARY OF DAM SAFETY ANALYSIS

1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	739.00	739.00	742.10
STORAGE	175.	175.	262.
OUTFLOW	0.	0.	1185.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	740.93	0.00	226.	549.	0.00	16.33	0.00
.15	741.56	0.00	245.	873.	0.00	16.33	0.00
.18	741.92	0.00	257.	1068.	0.00	16.25	0.00
.20	742.15	.05	264.	1216.	.33	16.25	0.00

END

DATE
FILMED

11-81

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